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\*\*REGISTERED PATENT AGENTS

November 22, 2000

WRITER'S DIRECT NUMBER:

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INTERNET ADDRESS:

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Commissioner for Patents  
Washington, D.C. 20231

**Box: Patent Application**

Re: U.S. Non-Provisional Utility Patent Application  
(Continuation of U.S. Patent Appl. No. 09/474,127; Filed: December 29, 1999)  
Application No.: To Be Assigned: Filed: Herewith  
For: **Axle Driving Apparatus**  
Inventors: OKADA *et al.*  
Our Ref: 0666.0230000

Sir:

Transmitted herewith for appropriate action are the following documents:

1. PTO Fee Transmittal (Form PTO/SB17) (*in duplicate*);
2. USPTO Utility Patent Application Transmittal Form PTO/SB/05 (*in duplicate*);
3. U.S. Utility Patent Application entitled:

**Axle Driving Apparatus**

and naming as inventors:

Hideaki OKADA  
Shusuke NEMOTO

the application comprising:

- a. specification containing:

Commissioner for Patents  
November 22, 2000  
Page 2

- i. 17 pages of description prior to the claims;
- ii. 3 pages of claims (1-6);
- iii. A one (1) page abstract;
- b. 14 sheets of drawings: (Figures 1-16);
- c. A copy of the executed Declaration and Power of Attorney,  
as originally filed in U.S. Appl. No. 07/304,581;
4. A Preliminary Amendment;
5. 37 C.F.R. § 1.136(a)(3) Authorization to Treat a Reply As Incorporating  
An Extension of Time (*in duplicate*);
6. Two (2) return postcards; and
7. Our Check No. 29567 for \$1,360.00 to cover:  
\$710.00 - Application Filing Fee;  
\$650.00 - Excess Claims Fee.

It is respectfully requested that the attached postcard be stamped with the date of filing of these documents, and that it be returned to our courier. In the event that extensions of time are necessary to prevent abandonment of this patent application, then such extensions of time are hereby petitioned.

The U.S. Patent and Trademark Office is hereby authorized to charge any fee deficiency, or credit any overpayment, to our Deposit Account No. 19-0036. A duplicate copy of this letter is enclosed.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.



Tracy-Gene G. Durkin  
Attorney for Applicants  
Registration No. 32,831

TGD/ALF:dcw

Enclosures

P:\USERS\DWRIGHT\General\TRACY-GENE DURKIN\CON-SKGF-TRANS-0666 0230000-2  
SKGF Rev. 4/27/00 mac

Please type a sign (+) inside this box →

PTO/SB/05 (11-00)

Approved for use through 10/31/2002. OMB 0651-0032  
Patent and Trademark Office: U S DEPARTMENT OF COMMERCE

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# UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR § 1.53(b))

Attorney Docket No.	0666.0230000
First Inventor	Hideaki OKADA
Title	Axle Driving Apparatus
Express Mail Label No.	

## APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents

## ADDRESS TO:

Assistant Commissioner for Patents  
Box Patent Application  
Washington, DC 20231

1. ☒ Fee Transmittal Form (e.g., PTO/SB/17)  
(Submit an original, and a duplicate for fee processing)

2. ☐ Applicant claims small entity status.  
See 37 CFR 1.27.

3. ☒ Specification [Total Pages 21]  
(preferred arrangement set forth below)  
- Descriptive title of the Invention  
- Cross Reference to Related Applications  
- Statement Regarding Fed sponsored R & D  
- Reference to sequence listing, a table,  
or a computer program listing appendix  
- Background of the Invention  
- Brief Summary of the Invention  
- Brief Description of the Drawings (if filed)  
- Detailed Description  
- Claim(s)  
- Abstract of the Disclosure

☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 14]

Oath or Declaration [Total Pages 4]

a. ☐ Newly executed (original or copy)

b. ☒ Copy from a prior application (37 CFR 1.63(d))  
(for continuation/divisional with Box 17 completed)

i. ☐ DELETION OF INVENTOR(S)  
Signed statement attached deleting inventor(s)  
named in the prior application, see 37 CFR §§  
1.63(d)(2) and 1.33(b)

4. ☐ Application Data Sheet. See 37 CFR 1.76.

7. ☐ CD-ROM or CD-R in duplicate, large table or Computer Program  
(Appendix)

8. Nucleotide and/or Amino Acid Sequence Submission  
(if applicable, all necessary)

a. ☐ Computer Readable Form (CRF)

b. Specification Sequence Listing on:

i. ☐ CD-ROM or CD-R (2 copies); or

ii. ☐ paper

c. ☐ Statements verifying identity of above copies

JC929 U.S. PTO  
09/7/17115  
11/22/00

## ACCOMPANYING APPLICATION PARTS

9. ☐ Assignment Papers (cover sheet & document(s))

10. ☐ 37 CFR 3.73(b) Statement ☐ Power of Attorney  
(when there is an assignee)

11. ☐ English Translation Document (if applicable)

12. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations

13. ☒ Preliminary Amendment

14. ☒ Return Receipt Postcard (MPEP 503)  
(Should be specifically itemized)

15. ☐ Certified Copy of Priority Document(s)  
(if foreign priority is claimed)

16. ☐ Request and Certification under 35 U.S.C. 122(b)(2)(B)(i) Applicant must  
attach form PTO/SB/35 or its equivalent

17. ☒ Other: Authorization under 37 C.F.R. § 1.136(a)(3)

17. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:

☒ Continuation ☐ Divisional ☐ Continuation-in-Part (CIP) of prior application No: 09/474,127

Prior application information: Examiner D. Depumpe Group/Art Unit: 3682

For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the continuing or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

☐ Customer Number or Bar Code Label

(Insert Customer No. or Attach bar code label here) or ☒ Correspondence address below

NAME	STERNE, KESSLER, GOLDSTEIN & FOX P L L C				
	Attorneys at Law				
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NAME (Print/Type)	Tracy-Gene G. Durkin	Registration No. (Attorney/Agent)	32,831
SIGNATURE	<i>Tracy Gene Durkin</i>	Date	11/22/00

Burden Hour Statement: this form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231.

# FEE TRANSMITTAL for FY 2001

Patent fees are subject to annual revision

## Complete if Known

Application Number	To Be Assigned (continuation of Appl. No. 09/474,127)
Filing Date	Herewith
First Named Inventor	Hideaki OKADA
Examiner Name	To Be Assigned
Group Art Unit	To Be Assigned
Attorney Docket No.	0666.0230000

TOTAL AMOUNT OF PAYMENT (\$ ) 1,360.00

## METHOD OF PAYMENT (check one)

1. ☐ The Commissioner is hereby authorized to charge indicated fees and credit any overpayment to:

Deposit Account Number 19-0036  
Deposit Account Name Sterne, Kessler, Goldstein & Fox  
P L L C

- ☐ Charge Any Additional Fee Required  
Under 37 CFR §§ 1.16 and 1.17

- ☐ Applicant claims small entity status  
See 37 CFR 1.27

2. ☒ Payment Enclosed:

- ☒ Check ☐ Credit card ☐ Money Order ☒ Other\*

\*Charge any deficiencies or credit any overpayments in the fees or fee calculations of Parts 1, 2 and 3 below to Deposit Account No. 19-0036

## FEE CALCULATION

### 1. BASIC FILING FEE

Large Fee Code	Entity Fee (\$)	Small Fee Code	Entity Fee (\$)	Fee Description	Fee Paid
101	710	201	355	Utility filing fee	\$710.00
106	320	206	160	Design filing fee	
107	490	207	245	Plant filing fee	
108	710	208	355	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL (1) (\$ ) 710.00

### 2. EXTRA CLAIM FEES

	Extra	Fee from below	Fee Paid
Total Claims 25 - 20** = 5	X 18.00	=	\$90.00
Indep. Claims 10 - 3** = 7	X 80.00	=	\$560.00
Multiple Dependent		=	

Large Fee Code	Entity Fee (\$)	Small Fee Code	Entity Fee (\$)	Fee Description
103	18	203	9	Claims in excess of 20
102	80	202	40	Independent claims in excess of 3
104	270	204	135	Multiple dependent claim
108	80	209	40	**Reissue independent claims over original patent
110	18	210	9	**Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) (\$ ) 650.00

\*\*or number previously paid, if greater, For Reissues, see above

### 3. ADDITIONAL FEES

Large Entity Small Entity

Fee Code	Fee (\$)	Fee Code	Fee (\$)	Fee Description	Fee paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for <i>ex parte</i> reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	390	216	195	Extension for reply within second month	
117	890	217	445	Extension for reply within third month	
118	1,390	218	695	Extension for reply within fourth month	
128	1,890	228	945	Extension for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,240	241	620	Petition to revive - unintentional	
142	1,240	242	620	Utility issue fee (or reissue)	
143	440	243	220	Design issue fee	
144	600	244	300	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	130	123	130	Petitions related to provisional applications	
126	180	126	180	Submission of Information Disclosure Stmt	
581	40	481	40	Recording each patent assignment per property (times number of properties)	
146	710	246	355	Filing a submission after final rejection (37 CFR 1.129(a))	
149	710	249	355	For each additional invention to be examined (37 CFR 1.129(b))	
179	710	279	355	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify) : EOT Authorization to Incorporation into Reply


Other fee (specify) .

\*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$ ) 0

## SUBMITTED BY

## Complete (if applicable)

Name (Print/Type)	Tracy-Gene G Durkin	Registration No (Attorney/Agent)	32,831	Telephone	202-371-2600
Signature		Date	11/22/00		

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Okada *et al.*

Appl. No. To be Assigned  
(Continuation of U.S. Appl. No. 09/474,127; Filed:  
December 29, 1999)

Filed: Herewith

For: **Axle Driving Apparatus**

Art Unit: To be Assigned

Examiner: To be Assigned

Atty. Docket: 0666.023000O/TGD/ALF

**Preliminary Amendment**

Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

Please enter the following amendment into the application prior to the examination thereof.

Please amend the captioned application as follows:

***In the Claims:***

Please cancel claims 1-6 without prejudice to or disclaimer of the subject matter contained therein. Please add the following new claims:

- 7. An axle driving apparatus, comprising:
- a hydraulic pump including a vertical pump shaft also serving as an input shaft and a pump piston disposed parallel to said pump shaft;
  - a hydraulic motor including a motor shaft and a motor piston disposed parallel to said motor shaft;
  - a center section for fluidly connecting said hydraulic pump and said hydraulic motor with each other, wherein said hydraulic pump and said hydraulic motor are mounted on

said center section so that said pump shaft and said motor shaft are disposed perpendicular to each other;

a differential gear interlocking with said motor shaft; and

a pair of horizontal axles as output means differentially connected with each other through said differential gear.

8. The axle driving apparatus as set forth in claim 7, further comprising:

a casing including an upper half casing part and a lower half casing part joined with each other, wherein said hydraulic pump, said hydraulic motor, said center section, said differential gear and said pair of axles are disposed in said casing.

9. The axle driving apparatus as set forth in claim 8, wherein said center section is fixed to said upper half casing part.

10. The axle driving apparatus as set forth in claim 9, further comprising:

a check valve disposed in said center section, where said center section is provided therein with a closed circuit for hydraulic connection of said hydraulic pump and said hydraulic motor and with an oil suction port, and wherein said check valve is interposed between said oil suction port and said closed circuit.

11. The axle driving apparatus as set forth in claim 10, further comprising:

a movable swash plate of said hydraulic pump disposed in said casing; and  
a bearing supported by said movable swash plate, said bearing abutting against said pump piston.

12. The axle driving apparatus as set forth in claim 11, further comprising:

a speed control lever shaft interlocking with said movable swash plate, said speed control lever shaft being rotatably supported by said upper half casing part.

13. An axle driving apparatus, comprising:
  - a casing;
  - a hydraulic pump disposed in said casing, said hydraulic pump including a pump shaft and a pump piston disposed parallel to said pump shaft;
  - a hydraulic motor disposed in said casing, said hydraulic motor including a motor shaft and a motor piston disposed parallel to said motor shaft; and
  - a center section disposed in said casing for fluidly connecting said hydraulic pump and said hydraulic motor with each other, wherein said hydraulic pump and said hydraulic motor are mounted on said center section so that said pump shaft and said motor shaft are disposed perpendicularly to each other.
14. The axle driving apparatus as set forth in claim 13, further comprising:
  - an upper half casing part and a lower half casing part joined with each other so as to constitute said casing, wherein said center section is fixed to said upper half casing part.
15. The axle driving apparatus as set forth in claim 14, further comprising:
  - a check valve disposed in said center section, wherein said center section is provided therein with a closed circuit for hydraulic connection of said hydraulic pump and said hydraulic motor and with an oil suction port, and wherein said check valve is interposed between said closed circuit and said oil suction port.
16. The axle driving apparatus as set forth in claim 15, further comprising:
  - a movable swash plate of said hydraulic pump disposed in said casing; and
  - a bearing supported by said movable swash plate, said bearing abutting against said pump piston.
17. The axle driving apparatus as set forth in claim 16, further comprising:
  - a speed control lever shaft interlocking with said movable swash plate, said speed control lever shaft being rotatably supported by said upper half casing part.

18. An axle driving apparatus, comprising:
- a casing including an upper half casing part and a lower half casing part joined with each other;
  - a hydraulic pump disposed in said casing, said hydraulic pump including a vertical pump shaft also serving as an input shaft and a pump piston disposed parallel to said pump shaft;
  - a hydraulic motor disposed in said casing, said hydraulic motor including a motor shaft and a motor piston disposed parallel to said motor shaft;
  - a center section disposed in said casing for fluidly connecting said hydraulic pump and said hydraulic motor with each other, wherein said hydraulic pump and said hydraulic motor are mounted on said center section so that said pump shaft and said motor shaft are disposed perpendicular to each other;
  - a differential gear interlocking with said motor shaft in said casing; and
  - a pair of axles as output means horizontally disposed in said casing and differentially connected with each other through said differential gear.
19. The axle driving apparatus as set forth in claim 18, wherein said center section is fixed to said upper half casing part.
20. An axle driving apparatus, comprising:
- a casing including an upper half casing part and a lower half casing part joined with each other;
  - a hydraulic pump disposed in said casing, said hydraulic pump including a pump shaft and a pump piston disposed parallel to said pump shaft;
  - a hydraulic motor disposed in said casing, said hydraulic motor including a motor shaft horizontally and rotatably supported between said upper half casing part and said lower half casing part and a motor piston disposed parallel to said motor shaft; and
  - a center section disposed in said casing for fluidly connecting said hydraulic pump and said hydraulic motor with each other, wherein said hydraulic pump and said



hydraulic motor are mounted on said center section so that said pump shaft and said motor shaft are disposed perpendicular to each other.

21. The axle driving apparatus as set forth in claim 20, wherein said center section is fixed to said upper half casing part.

22. An axle driving apparatus, comprising:

a hydraulic pump including a pump shaft also serving as an input shaft, a pump piston disposed parallel to said pump shaft, and a movable swash plate abutting against said pump piston, said movable swash plate being provided with a detent mechanism;

a hydraulic motor including a motor shaft and a motor piston disposed parallel to said motor shaft;

a center section for fluidly connecting said hydraulic pump and said hydraulic motor with each other, wherein said hydraulic pump and said hydraulic motor are mounted on said center section so that said pump shaft and said motor shaft are disposed perpendicular to each other;

a differential gear interlocking with said motor shaft; and

a pair of axles as output means differentially connected with each other through said differential gear, wherein said pair of axles are disposed perpendicularly to said pump shaft.

23. The axle driving apparatus as set forth in claim 22, further comprising:

a casing including an upper half casing part and a lower half casing part joined with each other, wherein said hydraulic pump, said hydraulic motor, said center section, said differential gear and said pair of axles are disposed in said casing.

24. The axle driving apparatus as set forth in claim 23, wherein said center section is fixed to said upper half casing part.

25. An axle driving apparatus, comprising:  
a casing including an upper half casing part and a lower half casing part joined with each other;  
a hydraulic pump disposed in said casing, said hydraulic pump including a pump shaft also serving as an input shaft, a pump piston disposed parallel to said pump shaft, and a movable swash plate abutting against said pump piston, said movable swash plate being provided with a detent mechanism;  
a hydraulic motor disposed in said casing, said hydraulic motor including a motor shaft and a motor piston disposed parallel to said motor shaft; and  
a center section disposed in said casing for fluidly connecting said hydraulic pump and said hydraulic motor with each other, wherein said hydraulic pump and said hydraulic motor are mounted on said center section so that said pump shaft and said motor shaft are disposed perpendicularly to each other.
26. The axle driving apparatus as set forth in claim 25, wherein said center section is fixed to said upper half casing part.
27. An axle driving apparatus, comprising:  
a hydraulic pump including a pump shaft also serving as an input shaft and a pump piston disposed parallel to said pump shaft;  
a hydraulic motor including a motor shaft and a motor piston disposed parallel to said motor shaft;  
a center section for fluidly connecting said hydraulic pump and said hydraulic motor with each other, wherein said hydraulic pump and said hydraulic motor are mounted on said center section so that said pump shaft and said motor shaft are disposed perpendicular to each other;  
a differential gear interlocking with said motor shaft; and  
a pair of axles as output means differentially connected with each other through said differential gear, wherein said pair of axles are disposed perpendicularly to said

pump shaft and parallel to said motor shaft, and wherein said pump shaft is disposed between said motor shaft and said pair of axles.

28. The axle driving apparatus as set forth in claim 27, further comprising: a casing including an upper half casing part and a lower half casing part joined with each other, wherein said hydraulic pump, said hydraulic motor, said center section, said differential gear and said pair of axles are disposed in said casing.

29. An axle driving apparatus, comprising:  
a casing including an upper half casing part and a lower half casing part joined with each other;  
a hydraulic pump disposed in said casing, said hydraulic pump including a vertical pump shaft also serving as an input shaft and a pump piston disposed parallel to said pump shaft;  
a hydraulic motor disposed in said casing, said hydraulic motor including a motor shaft and a motor piston disposed parallel to said motor shaft;  
a center section disposed in said casing for fluidly connecting said hydraulic pump and said hydraulic motor with each other, wherein said hydraulic pump and said hydraulic motor are mounted on said center section so that said pump shaft and said motor shaft are disposed perpendicularly to each other, and wherein said pump shaft is rotatably supported by said casing and said center section;  
a differential gear interlocking with said motor shaft in said casing; and  
a pair of axles as output means horizontally disposed in said casing and differentially connected with each other through said differential gear.

30. An axle driving apparatus, comprising:  
a casing including an upper half casing part and a lower half casing part joined with each other;

a hydraulic pump disposed in said casing, said hydraulic pump including a vertical pump shaft also serving as an input shaft and a pump piston disposed parallel to said pump shaft;

a hydraulic motor disposed in said casing, said hydraulic motor including a motor shaft and a motor piston disposed parallel to said motor shaft; and

a center section disposed in said casing for fluidly connecting said hydraulic pump and said hydraulic motor with each other, wherein said hydraulic pump and said hydraulic motor are mounted on said center section so that said pump shaft and said motor shaft are disposed perpendicular to each other, and wherein said pump shaft is rotatably supported by said casing and said center section.

31. A hydrostatic transmission, comprising:

an axle;

a hydraulic motor including a motor shaft interlocking with said axle, wherein said motor shaft is disposed parallel to said axle; and

a hydraulic pump including a pump shaft, wherein said pump shaft is vertically disposed perpendicularly to said motor shaft between said axle and said motor shaft.--

***Remarks***

Upon entry of the foregoing amendment, independent claims 7-31 are pending in the application, with claims 7, 13, 18, 20, 22, 25, 27, 29, 30, and 31 being the independent claims. Claims 1-6 are cancelled without prejudice to or disclaimer of the subject matter therein. New claims 7-31 are added. The subject matter of new claims 7-31 is contained in the application as originally filed. Accordingly, the foregoing amendment does not introduce new matter and its entry is respectfully requested.

If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at the number provided.

Respectfully submitted,

STERNE, KESSLER, GOLDSTEIN & FOX P.L.L.C.



Tracy-Gene G. Durkin  
Attorney for Applicants  
Registration No. 32,831

Date: November 22, 2000

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SKGF Rev. 11/12/97mac

## SPECIFICATION

### 1. Title of the Invention

Axle Driving Apparatus

### 2. Field of the Invention

The present invention relates to an axle driving apparatus with a hydro-static-transmission used as a driving apparatus for a light tractor.

### 3. Background of the Invention

Conventionally, an axle driving apparatus, which vertically divides a casing thereof and journals axles at the divided surfaces and drives the axles by a hydro-static-transmission attached to the casing, is well known as disclosed in, for example, the Japanese Utility Model Publication Gazette No. Sho 62-44198 and the Japanese Patent Laid-Open Gazette Sho 62-101945, filed by the same applicant.

In the conventional prior art, however, the hydro-static-transmission separate from the axle driving apparatus is fixed to the outside thereof in a manner of being exposed, whereby the apparatus is large-sized as a whole and larger in the gross weight. Also, it is required for driving the horizontally disposed axles by a motor shaft of a hydraulic motor vertically disposed at the exterior to interpose bevel gears in a drive system for both

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the motor shaft and axles.

#### 4. Summary of the Invention

An object of the invention is to provide an axle driving apparatus which contains the hydraulic motor and a hydraulic pump at the hydro-static-transmission in a transmission casing of the axle driving apparatus and a center section for connecting the hydraulic motor and hydraulic pump is disposed in the transmission casing, the center section being fixed to the butt joint surface thereof.

The center section is formed in a L-like shape when viewed in section and an oil passage from the hydraulic pump to the hydraulic motor is bent at a right angle to thereby extend the motor shaft in parallel to the axle. Hence, instead of conventional bevel gears used to turn the rotation direction, the oil passage in the center section is used to turn the power transmitting direction.

In a case where the center section is fixed to the butt joint surfaces to the half casings, when the half casings are fixedly jointed directly with aluminum die casting by use of four bolts, the center section may be distorted, thereby using three tightening bolts.

The above and further objects and novel features

of the invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings.

#### 5. Brief Description of the Drawings

Fig. 1 is a side view of a light tractor attached with an axle driving apparatus of the invention,

Fig. 2 is a sectional front view thereof,

Fig. 3 is a sectional view taken on the line I-I in Fig. 2, in which an upper half casing is removed,

Fig. 4 is a sectional view taken on the line V-V in Fig. 3,

Fig. 5 is a sectional view taken on the line VI-VI in Fig. 3,

Fig. 6 is a sectional view taken on the line II-II in Fig. 3,

Fig. 7 is a sectional front view of a modified embodiment of the axle driving apparatus of the invention, in which check valves are changed in arrangement thereof,

Fig. 8 is a plan view of the same,

Fig. 9 is a sectional view taken on the line III-III in Fig. 7 ,

Fig. 10 is a sectional view taken on the line



IV-IV in Fig.7,

Fig. 11 is a perspective exploded view of the axle driving apparatus of the invention,

Fig. 12 is a sectional front view of another modified embodiment of the invention, in which a center section is fixed to the inner surface of the bottom wall of a lower half casing,

Fig. 13 is a plan view of the Fig. 12 embodiment,

Fig. 14 is a sectional front view of a further modified embodiment of the invention, in which a center section has three bolt-bores into which three fixing bolts are inserted so that the center section is fixed therethrough to the upper half casing,

Fig. 15 is a plan view of the Fig. 14 embodiment, and

Fig. 16 is a sectional plan view of the center section.

#### 6. Description of the Preferred Embodiments

Referring to Fig. 1, a light tractor loading thereon an engine E of a vertical crank shaft is shown.

A pulley is fixed to the vertical crank shaft of the engine so that a driving power is transmitted

from the pulley through a belt to a pulley fixed to a pump shaft 4 of a hydraulic pump P projecting upwardly from an axle driving apparatus of the invention.

The tractor is provided at the front or under the body with a mower R or R' to thereby mow a lawn.

The present invention relates to the axle driving apparatus for driving axles 13 at the tractor.

Next, the axle driving apparatus will be detailed of its construction in accordance with Figs. 1 through 6.

A transmission casing of the axle driving apparatus is formed in upper and lower half casings 1 and 2, both the casings being jointed to form one closed-type transmission casing.

Between the butt joint surfaces of the upper and lower half casings 1 and 2 are held bearings to the axles 13 and a counter shaft 24 and a bearing 34 for one end of a motor shaft 5.

At the lower surface of the upper half casing 1 is formed a mounting surface so that a center section 3 fixedly supporting the hydraulic pump P and a hydraulic motor M is mountable to the mounting surface through bolts 39 inserted into bolt holes 3g from below.

In the state where the center section 3 fixing thereto the hydraulic motor M and hydraulic pump P is mounted to the lower surface of the upper half casing 1, the lower half casing 2 is jointed from below with the lower surface of the upper half casing 1 in a manner of closing the lower half casing 2 and bolts are used to connect both the upper and lower half casings 1 and 2.

The upper and lower half casings 1 and 2 are formed by aluminum die casting, whereby parts subjected to mechanical processing are reduced to lower the manufacturing cost.

The HST type transmission stored within the axle driving apparatus comprises the hydraulic pump P, center section 3 and hydraulic motor M, so that a pump mounting surface 3d and a motor mounting surface 3e are formed in the plane perpendicular to the center section 3.

Pairs of crescent-shaped oil passages 3a' and 3b' and 3a" and 3b" are formed at the pump mounting surface 3d and motor mounting surface 3e, the pair of crescent-shaped oil passages 3a" and 3b" at the motor mounting surface 3e and pair of crescent-shaped oil passages 3a' and 3b' at the pump mounting surface 3d being connected to two oil passages 3a

and 3b to constitute a closed circuit.

A cylinder block 10 for the hydraulic pump P is rotatably mounted on the pump mounting surface 3d and pistons 12 are inserted vertically slidably into a plurality of piston holes at the cylinder block 10 respectively.

When the pump shaft 4 supported by a bearing 31 at the upper half casing 1 and a spherical bush 32 at the pump mounting surface 3d is rotated, the cylinder block 10 and pistons 12 rotate.

A thrust bearing 15 abutting against the upper end of each piston is changed at an angle by a swash plate 9, so that the discharge rate and discharge direction of the hydraulic pump P are changed to supply the discharged pressure oil from the oil passages 3a' and 3b' at the center section 3 to the hydraulic motor M through the oil passages 3a and 3b.

As shown in Fig. 4, the swash plate 9 is changeable of its angle through a positioning plate 6a in association with rotation of a speed change lever shaft 6, a detent unit 20 for holding the neutral position of the speed change lever shaft 6 being constituted in the upper half casing 1.

The detent unit 20 is fitted into a recess 6b at the positioning plate 6a, thereby enabling the

neutral position to be ensured.

As shown in Figs. 2 and 3, a short-circuit valve 25 of slidable selector valve for short-circuiting between the two oil passages 3a and 3b at the discharge side and the return side is disposed, so that when the valve 25 is changed over to haul the body of tractor, generation of the state where the hydraulic motor M side is driven to send the pressure oil toward the hydraulic pump side can be avoided.

Reference numeral 7 designates a control for operating the short-circuit valve 25.

The short-circuit valve 25 and control 7 are slidably operated to push to be disengageable or pull without engagement in order to be controllable in the abutting condition. Such construction enables simple assembly of the apparatus.

Between the oil passages 3a and 3b at the center section 3 are interposed check valves 26 and 27 to form an oil feed route 30, and between the check valves 26 and 27 is bored an operating oil suction port 3c extending downwardly.

In the lower end of operating oil suction port 3c is fitted an oil filter 8 formed of a spongy fine-porous material, the oil filter 8 contacting

with the lower half casing 2 so as to be held thereto.

Thus, the oil filter 8, operating oil suction port 3c and check valves 26 and 27 are provided to communicate with the oil passages 3a and 3b through the check valves 26 and 27, whereby in a case where the hydraulic motor M and hydraulic pump P operate and the operating oil leaks from the interior of the closed circuit so as to decrease, the oil passage 3a or 3b generates therein negative pressure so that lubricating oil in the casing is taken in as the operating oil.

In addition, reference numeral O designates an oil level of lubricating oil filled into the transmission casing.

The pump mounting surface 3d at the center section 3 is somewhat larger in its flat surface to also serve as the surface through which the center section 3 is mounted to the lower surface of the upper half casing 1.

A cylinder block 11 is rotatably mounted onto the motor mounting surface 3e at the center section 3, and pistons 14 are slidably fitted into a plurality of piston holes at the cylinder block 11 and always abut at the heads against a thrust bearing 16. In such construction, the pistons 14 push the thrust

bearing 16 through the pressure oil from the oil passages 3a and 3b and slide down at the heads along the slanted surface of the thrust bearing so as to generate a torque, thereby rotating the cylinder block 11 and motor shaft 5.

The thrust bearing 16 is supported by an annular support 35 in relation of being slanted at a predetermined angle, the annular support 35 being fixedly sandwiched between the upper and lower half casings 1 and 2.

The motor shaft 5 is provided at one axial end journalled to the center section 3 with a spherical bush 33 and at the other end with a spherical bush 34, which are sandwiched between the upper and lower half casings 1 and 2.

A gear 17 is mounted on the motor shaft 5 and engages with a gear 21 on the counter shaft 24, the gears 17 and 21 constituting the first deceleration means.

A small diameter gear 22 on the counter shaft 24 engages with a ring gear 23 at a differential gear unit D, which gives differential rotations to drive the axles 13.

The small diameter gear 22 and ring gear 23 constitute the second deceleration means.

A brake drum 18 is fixed to the foremost end of the motor shaft 5 and brake shoes are expanded radially outwardly by a brake lever 19 to contact with the brake drum 18, thereby exerting the braking action.

In Fig. 6, part of motor mounting surface 3e, against which the motor casing 11 for the hydraulic motor M abuts, is shown.

Referring to Figs. 7, 8, 9 and 10, a modified embodiment of the axle driving apparatus of the invention will be described.

In the embodiment shown in Figs. 2 and 3, the oil passages 3a and 3b and supply oil passage 30 are provided at the same plane, but in this case, the motor mounting surface 3e must separate with respect to the pump mounting surface 3d, whereby the center section 3 cannot be compact to that extent and also the casing becomes larger.

Therefore, in the embodiment shown in Figs. 7 through 10, in order to eliminate the above defects, the supply oil passage 30 is disposed to overlap with the oil passages 3a and 3b in a range of thickness of the lower portion of the center section 3 and below the oil passages 3a and 3b.

The supply oil passage 30 is bored to communicate



at the upper half thereof with the lower halves in a manner of overlapping therewith. Hence, the oil passage connecting both the oil passages 30 and 3a, 3b is not required, thereby enabling the center section 3 to be made as smaller as possible in thickness.

At the center of the supply oil passage 30 is open an operating oil suction port 3c toward an oil filter 8 positioned below, and check valves 26 and 27 for opening or closing the communicating portion between the oil passages 3a and 3b are interposed in the supply oil passage 30 in relation of putting the operating oil suction port 3c between the check valves 26 and 27. Supply oil from the operating oil suction port 3c flows to the oil passages 3a and 3b through the portion at the supply oil passage 30 where the supply oil passes the check valves 26 and 27.

Thus, within the center section 3, the oil passages 3a and 3b, supply oil passage 30 and oil filter 8 overlap with each other, whereby the motor mounting surface 3e can approach the pump mounting surface 3d so as to enable the center section 3 to be compact.

Next, explanation will be given on the embodiment

in Figs. 12 and 13.

In this embodiment, a center section 3 abuts from above against the inner surface of the bottom wall of the lower half casing 2 and is fixed thereto.

Bolts 39 for fixing the center section 3 also are inserted from above into the bolt bores and screw with the lower half casing 2 respectively.

The center section 3 in this embodiment, as shown in Fig. 12, is about L-like-shaped when viewed in section from the rear surface.

Other constructions are about the same as the aforesaid embodiment.

Next, explanation will be given on the embodiment in Figs. 14, 15 and 16.

In this embodiment, three bolt bores 3g for three bolts 39 for fixing the center section 3 to the lower surface of the upper half casing 1 are provided at the center section 3, the three bolts 39 fixing the center section 3 to the upper half casing 1.

The center section 3 and upper half casing 1 constitute material with aluminum die casting, the mounting surfaces of both the members being not applied with machining.

Hence, when four bolts 39 are used to fix the

center section 3, an error in material may distort the same to worsen the tight condition.

In such case, three bolts 39 are inserted into three bolt bores 3g to fix the center section 3, thereby keeping all the bolts in good tight conditions.

In the embodiment in Figs. 14, 15 and 16, the pump mounting surface 3d is not adjacent to the motor mounting surface 3e at the center section 3, but near the axle 13.

Oil passages 3a and 3b are bored from a pair of crescent-shaped oil passages provided at the motor mounting surface 3e and extend in parallel to the axles 13, oil passages 3m and 3n being bored from a pair of crescent-shaped oil passages and extending perpendicularly to the axles 13, so that both oil passages 3m and 3a and 3n and 3b communicating with each other in the center section 3.

The open ends of oil passages 3m and 3n are plugged and the plugs are locked by projections formed at the bottom of the lower half casing 2 respectively.

Check valves 36 and 37 are provided at open ends of oil passages 3a and 3b, valve levers 36b and 37b of which are connected to a leaf spring 38.

The valve levers 36b and 37b are open only in the direction of flowing oil from the operating oil suction ports 3p and 3q into the oil passages 3a and 3b, so that the check valves 36 and 37 flowing into the oil passages 3a and 3b the supply operating oil after passing the plate-like oil filter 8 discharges to the exterior the pressure oil in the oil passages 3a and 3b by pushing the valve levers 36b and 37b through the leaf spring 38 pushed by a control 7, thereby serving as the short circuit valves to cause the free condition of hydraulic motor M.

As seen from the above, the center section 3 carrying the hydraulic pump P vertically and the hydraulic motor M horizontally is provided and contained within the transmission casing while carrying both the pump P and motor M, whereby the operating oil, even when leaked from the hydraulic pump P or hydraulic motor M, does not flow out to the exterior. Also, since the oil passages are formed at the center section 3, the piping is not at all required in or out the transmission casing.

The center section 3 is fixed to the upper half casing 1 or the lower half casing 2, thereby being simple to support. Also, the pump shaft 4 and motor

shaft 5 are simple to support.

The pump mounting surface 3d and motor mounting surface 3e are disposed in an L-like-shape and the center suction 3 is about L-like-shaped when viewed in section, so that the pump shaft 4 of input shaft is vertical and the motor shaft 5 of output shaft is horizontal, thereby making the axle driving apparatus compact without interposing the bevel gears, and the power transmitting direction can be changed at an angle of  $90^{\circ}$ , thereby having advantages for the tractor loading a vertical shaft - output shaft type engine.

The center section 3 is fixed to the lower side of the butt joint surface of the upper half casing 1 so that the pump mounting surface 3d is level with the mounting surface of the center section 3 to the upper half casing, whereby the surfaces of the upper half casing 1, lower half casing 2 and center section 3 can be restricted to a minimum.

Three bores 3g for the three fixing bolts 39 through which the center section 3 is fixed to the lower surface of the upper half casing 1 are formed, so that when the mounting surfaces of center section 3 and of upper half casing 1 are fixed as they are not flattened but cast, there is no fear that a

poor tightening condition is created on the center section 3.

The spherical bush 32 at the pump shaft 4 and spherical bush at the bearing for the motor shaft 5 are used, so that even when the center section 3 is mounted slantwise due to an assembly error or a machining error, a shift of the pump shaft 4 or the motor shaft 5 is absorbable.

Also, the spherical bush is smaller in the size than the usual bearing, whereby the bearing is disposable without interfering with the oil passages bored at the center section.

Although several embodiments have been described, they are merely exemplary of the invention and not to be constructed as limiting, the invention being defined solely by the appended claims.

7. What is claimed is:

1. An axle driving apparatus which contains a hydraulic pump driven by an engine and a hydraulic motor connected in association with axles in a transmission casing supporting left and right axles, characterized in that:

said hydraulic pump is vertically disposed so as to dispose a pump shaft vertically with respect to said axles,

said hydraulic motor is horizontally disposed so as to dispose a motor shaft in parallel to said axles, and

a center section to which said hydraulic pump and hydraulic motor are mountable is fixed in said transmission casing.

2. An axle driving apparatus according to Claim 1, characterized in that:

said transmission casing is divided into two vertical casings,

said pump mounting surface of said center section is disposed in parallel with respect to the divided surface of said transmission casing,

said motor mounting surface is disposed vertically to said divided surface, and

said center section is mounted to one of said

upper half casing and lower half casing, the axis of said motor shaft is positioned on the dividing line of said transmission casing, and bearings for said motor shaft are held between said upper half casing and said lower half casing.

3. An axle driving apparatus according to Claims 1 and 2, characterized in that said center section is provided at the pump mounting surface thereof with a rotary surface of a pump cylinder block and a bearing for said pump shaft and at said motor mounting surface with a rotary surface of a motor cylinder block and a bearing for said motor shaft, said pump mounting surface and motor mounting surface being disposed in an L-like shape, said center section being constituted to be about L-like-shaped when viewed in section.

4. An axle driving apparatus according to Claim 2, characterized in that said center section is mounted to said upper half casing, the casing mounting portion extending on the same plane as said pump mounting surface at said center section so as to be on the same plane as the butt joint surface of said upper half casing with respect to said lower half casing.

5. An axle driving apparatus according to Claims 1, 2 and 4, characterized in that said center section



is provided at three portions with bolt bores through which bolts are insertable from above respectively, so that said three bolts inserted into said bolt bores fix said center section to the lower surface of said upper half casing.

6. An axle driving apparatus according to Claim 3, characterized in that said bearings for said pump shaft and motor shaft use spherical bushes respectively.

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8. Abstract of the Disclosure

An axle driving apparatus wherein a hydraulic motor and a hydraulic pump for a hydro-static-transmission are housed in a transmission casing of the axle driving apparatus and a center section for connecting the hydraulic motor and hydraulic pump is disposed in the transmission casing, the center section being fixed at the butt joint portion at the transmission casing, and an oil passage from the hydraulic pump to the hydraulic motor at the center section is bent at a right angle so as to extend the motor shaft in parallel to the axles, so that the rotation direction of the motor shaft conventionally changed by bevel gears is changed by the oil passages in the center section.

FIG. 1

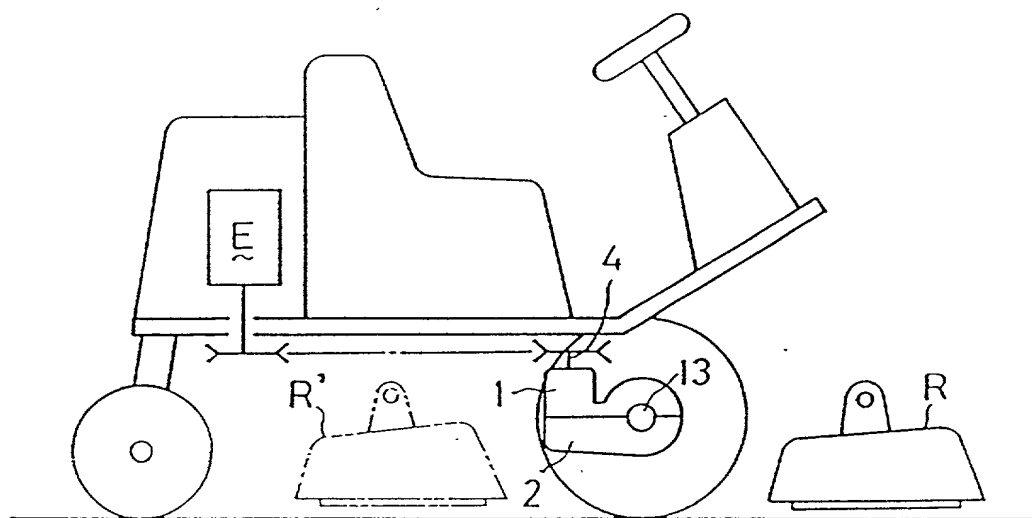
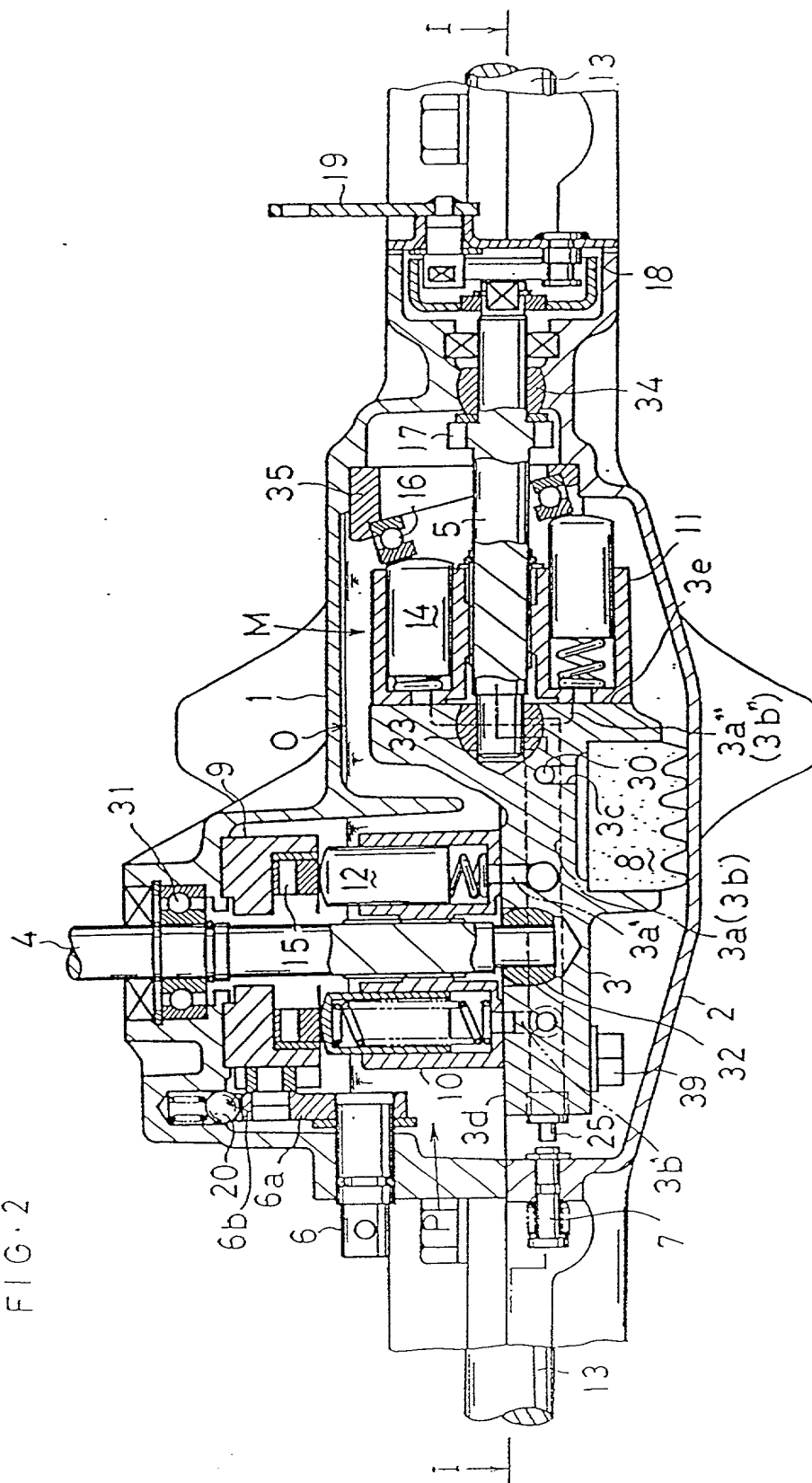


FIG. 2



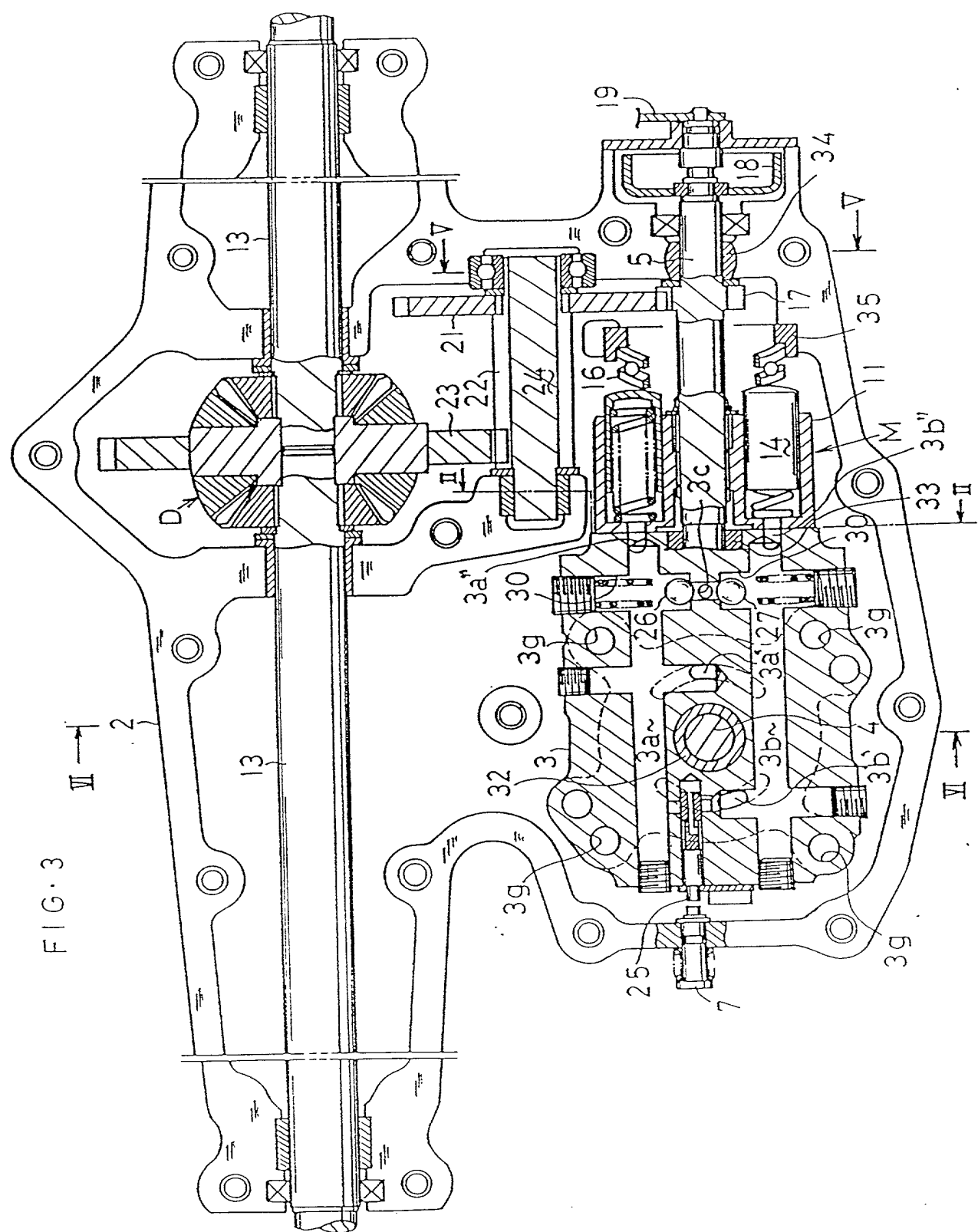


FIG-4

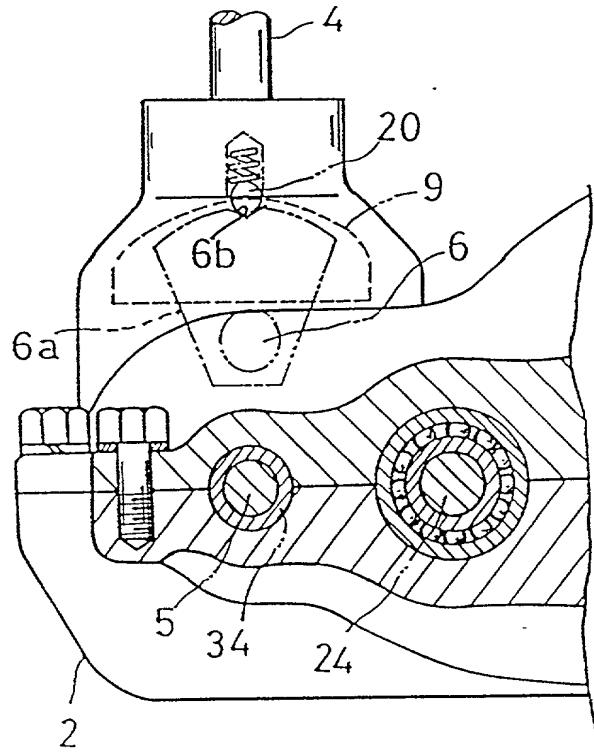


FIG. 5

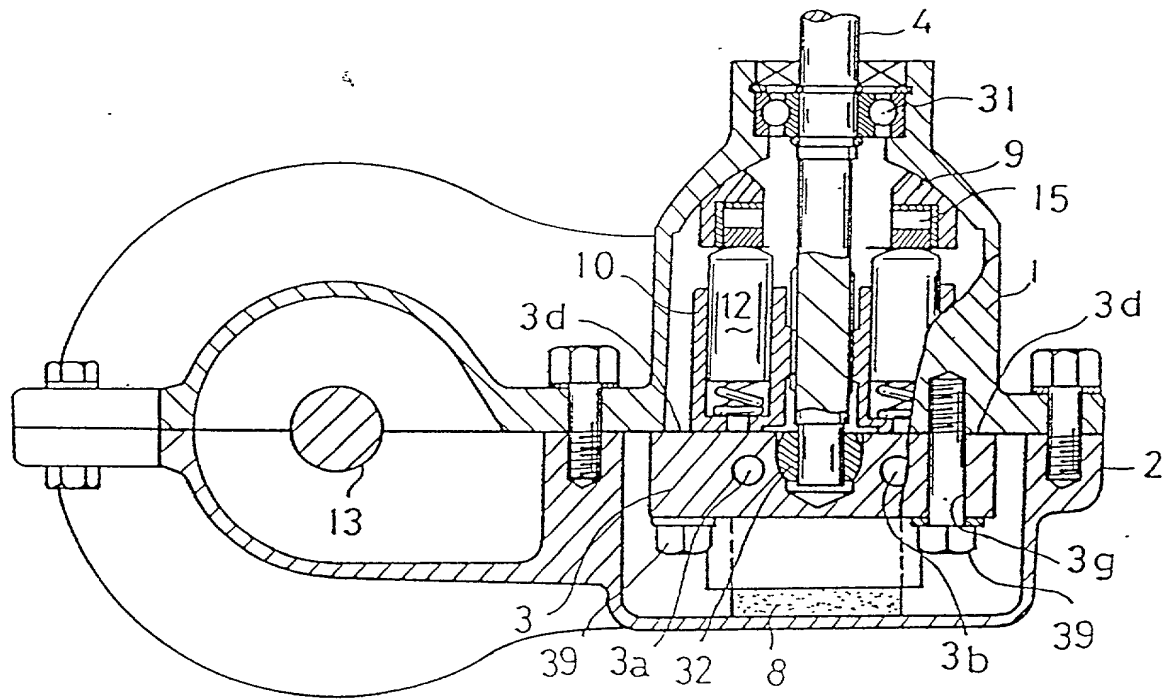
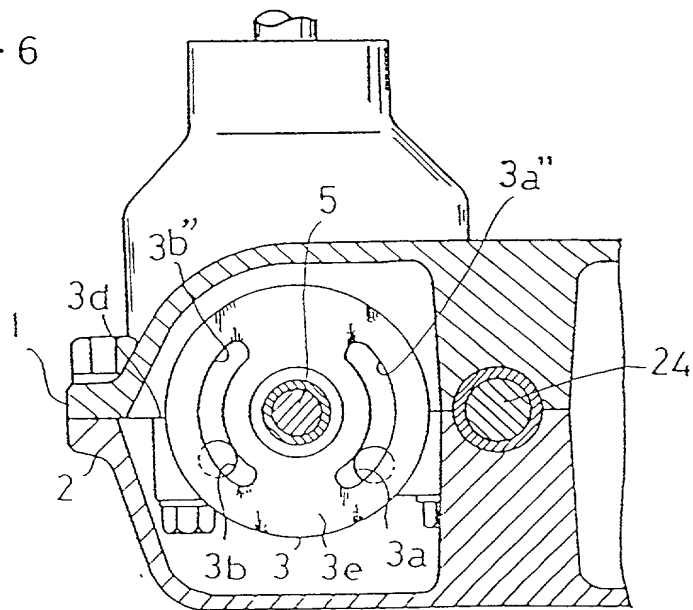
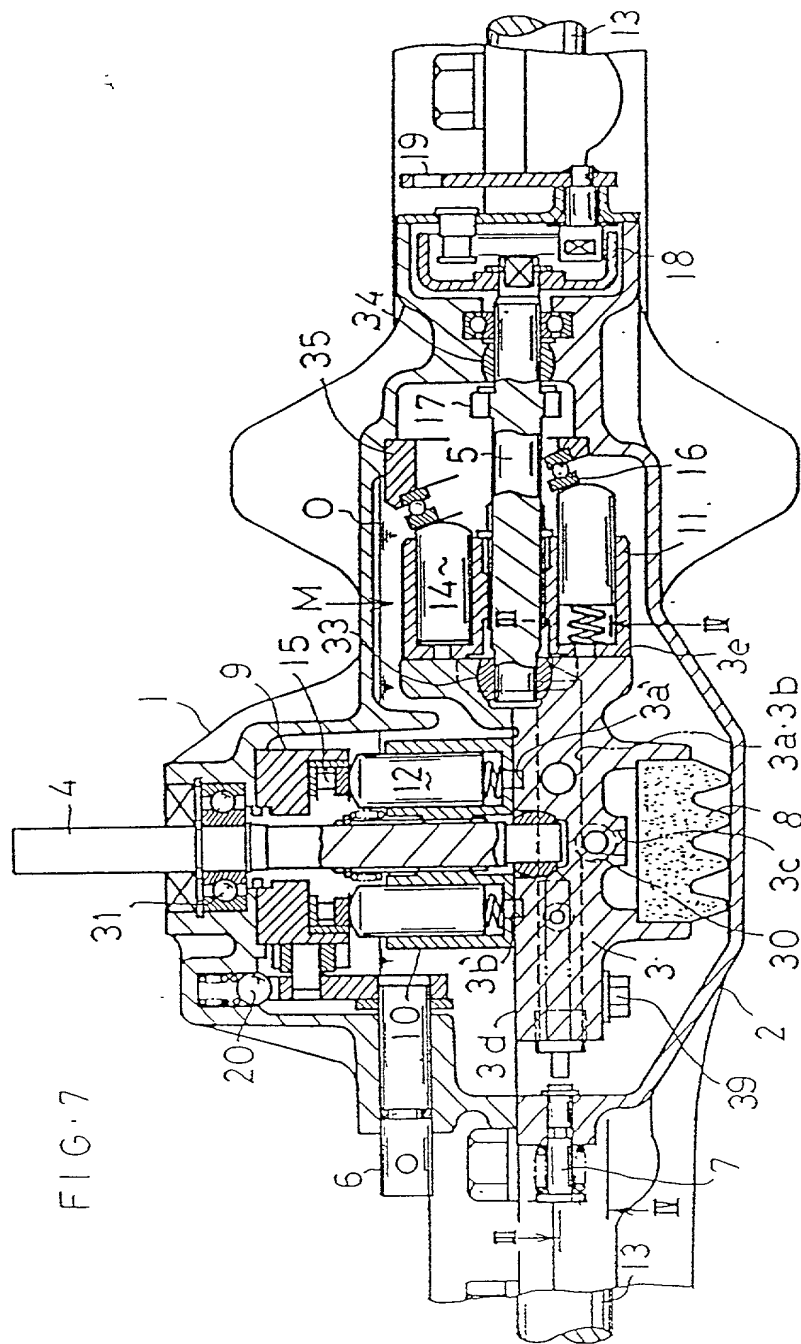


FIG. 6







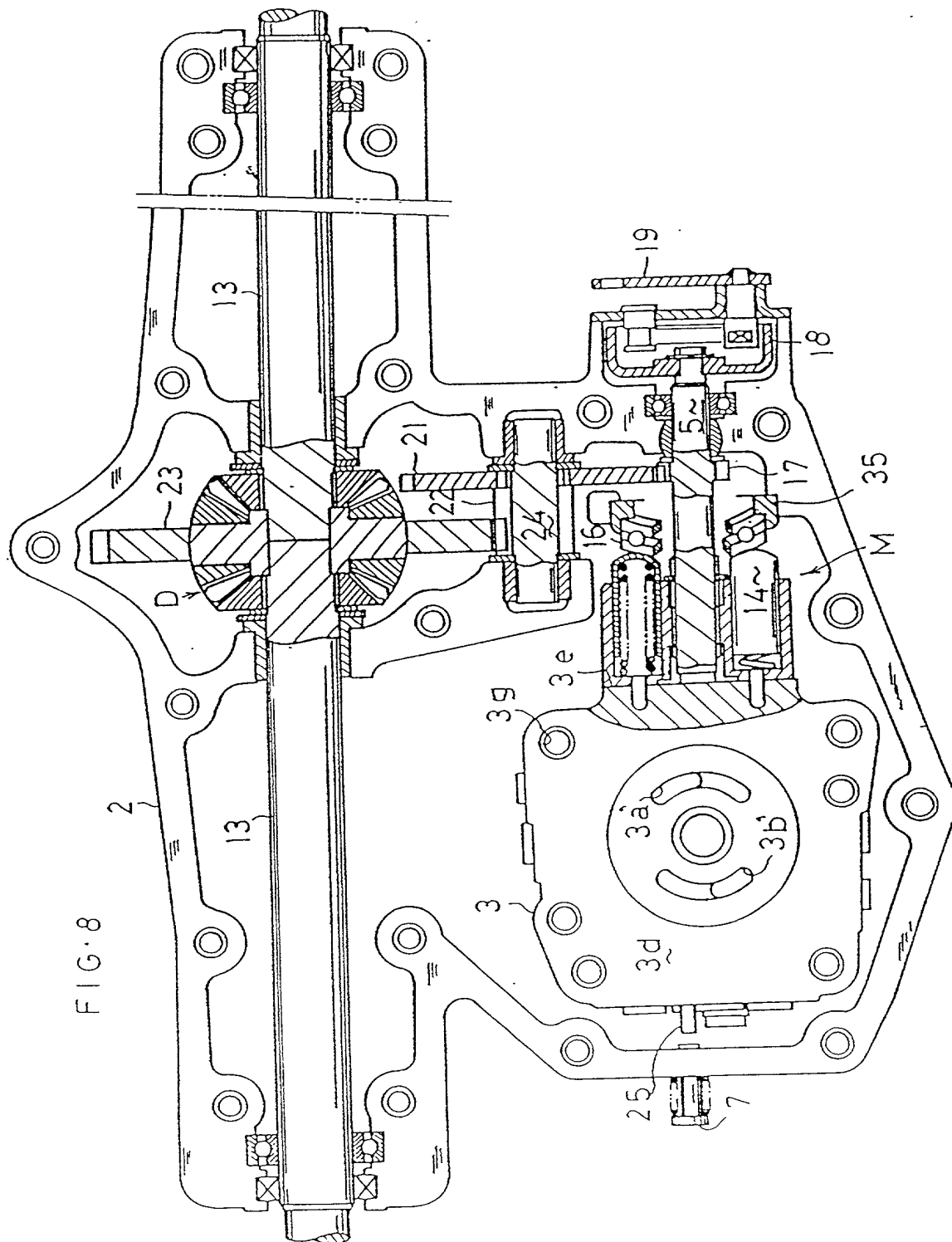


FIG. 9

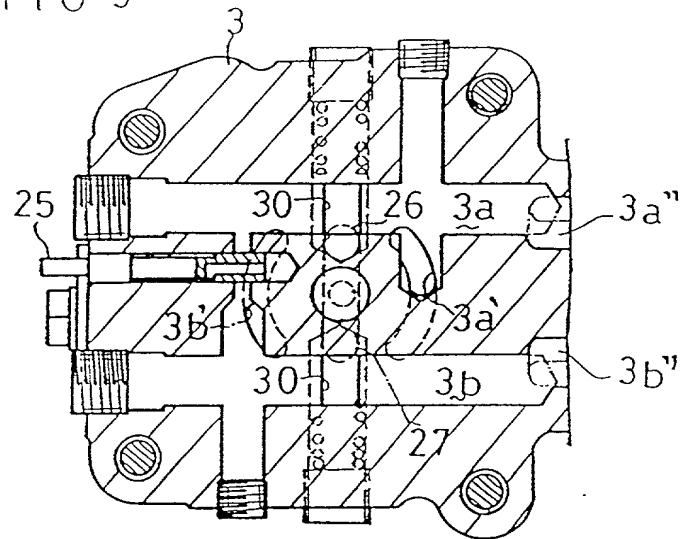


FIG. 10

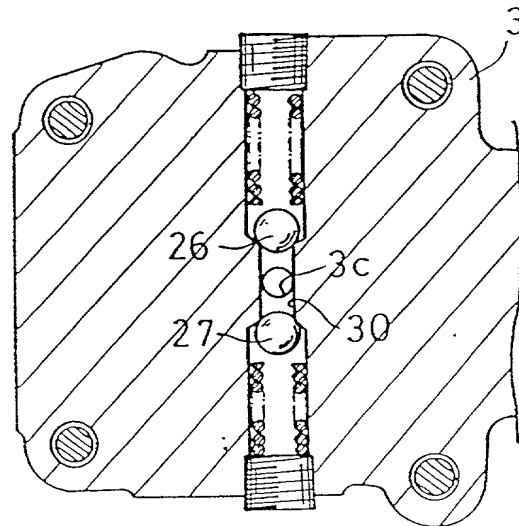
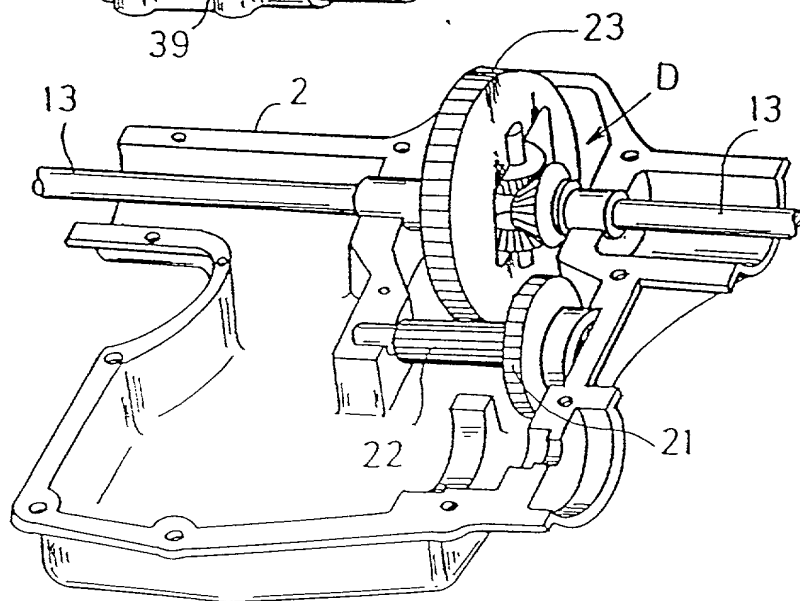
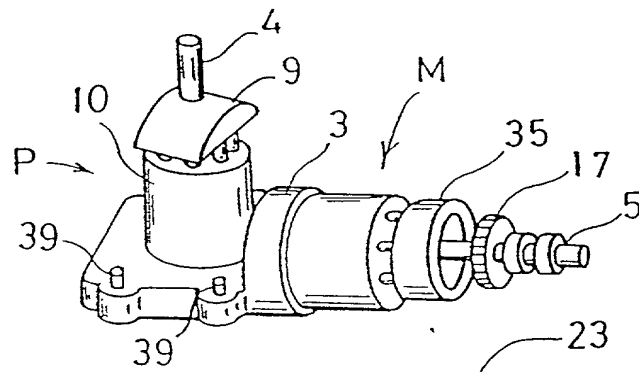
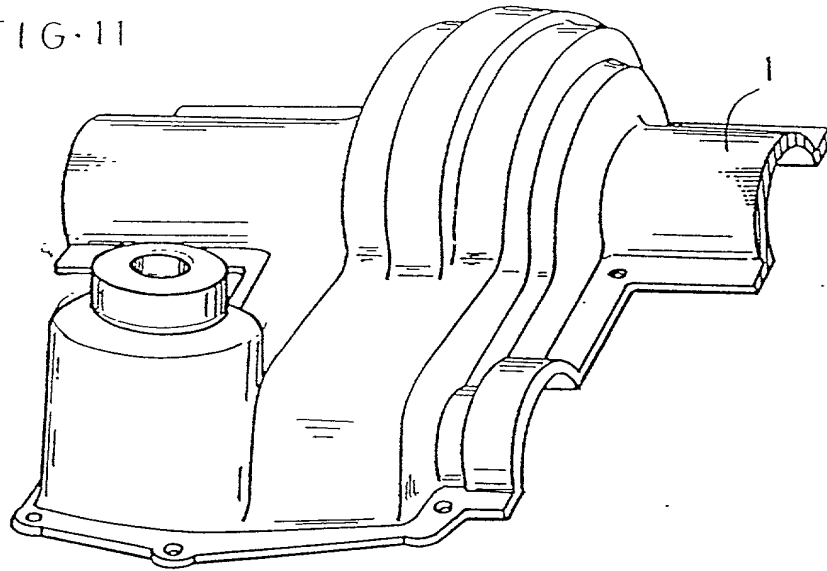
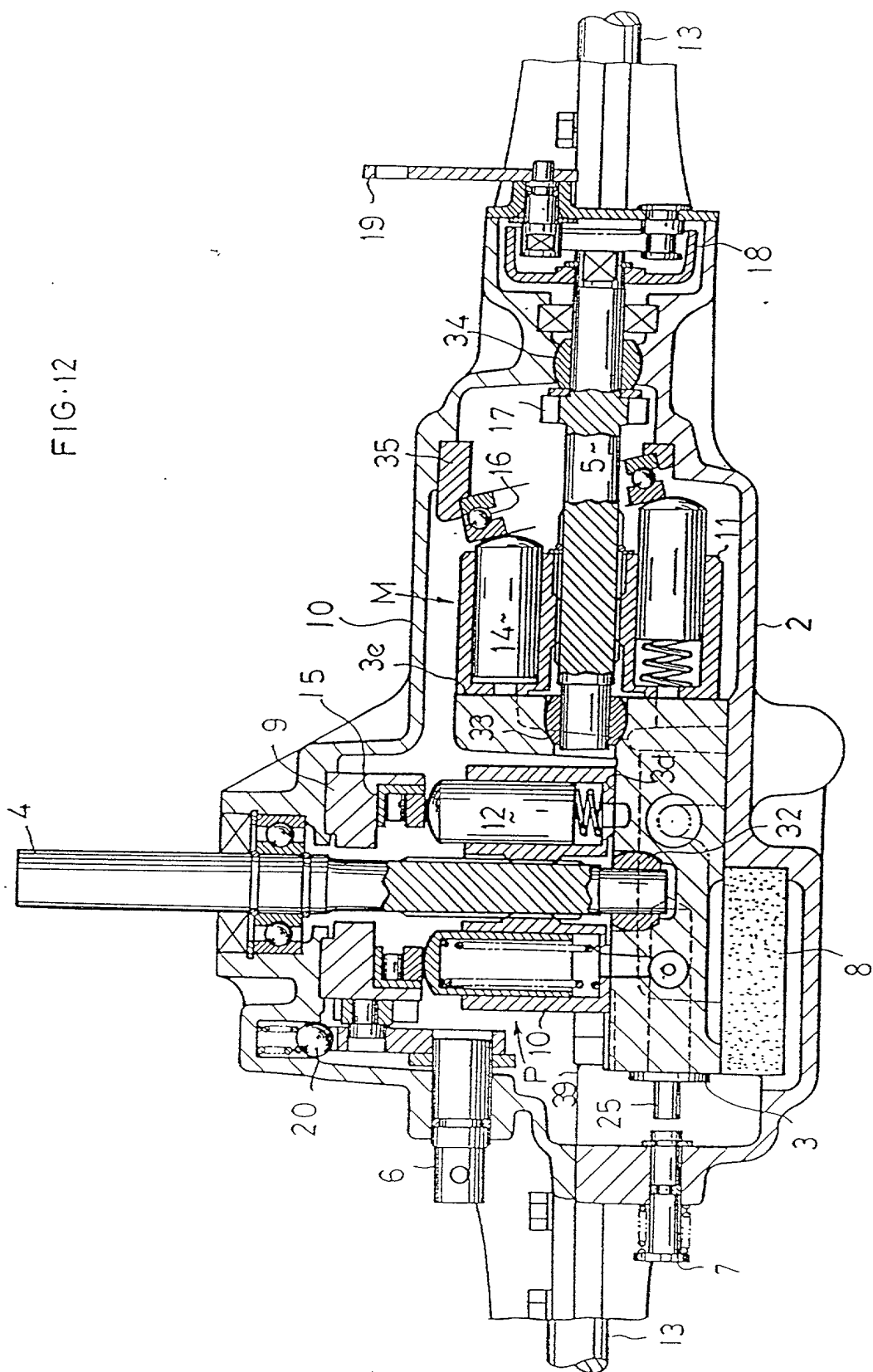


FIG. 11





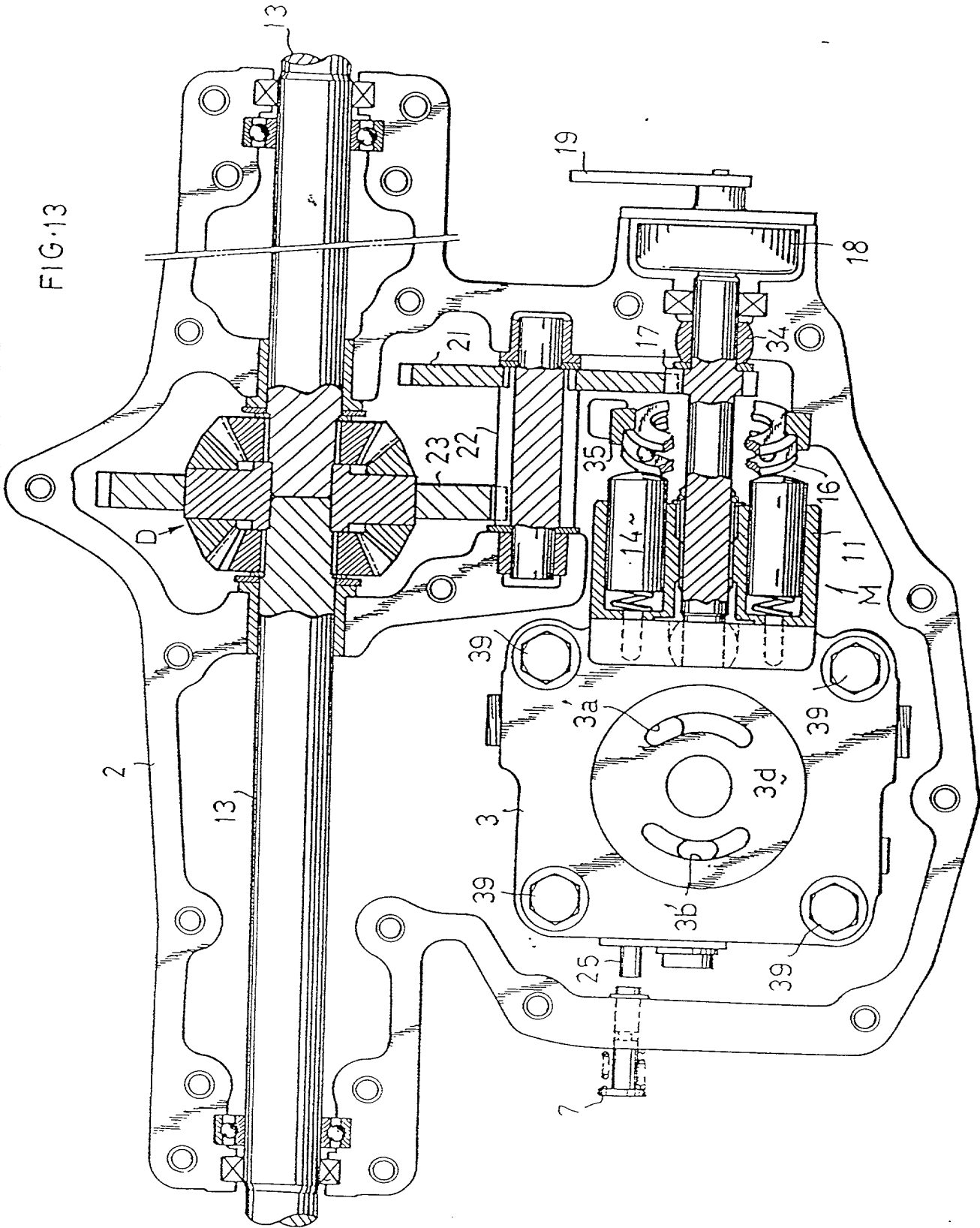


FIG. 14

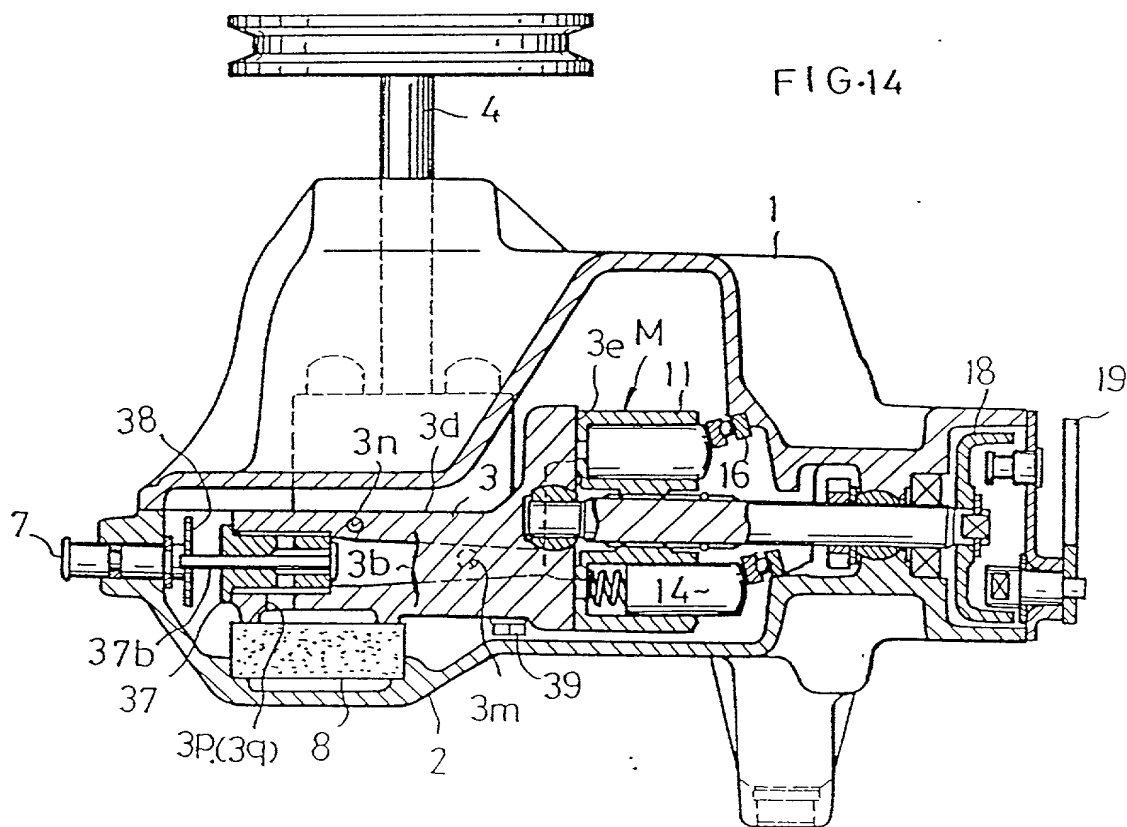


FIG.15

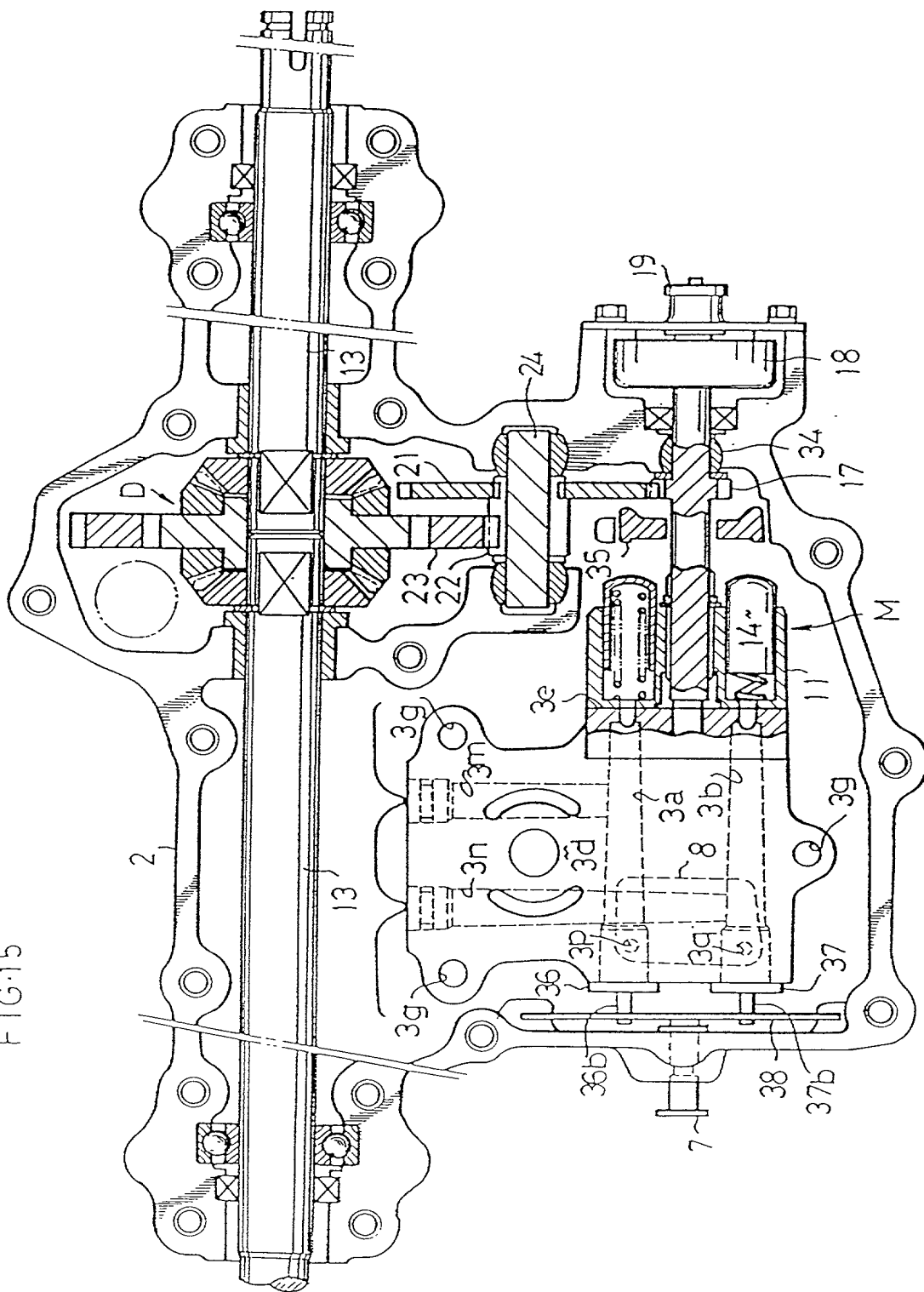
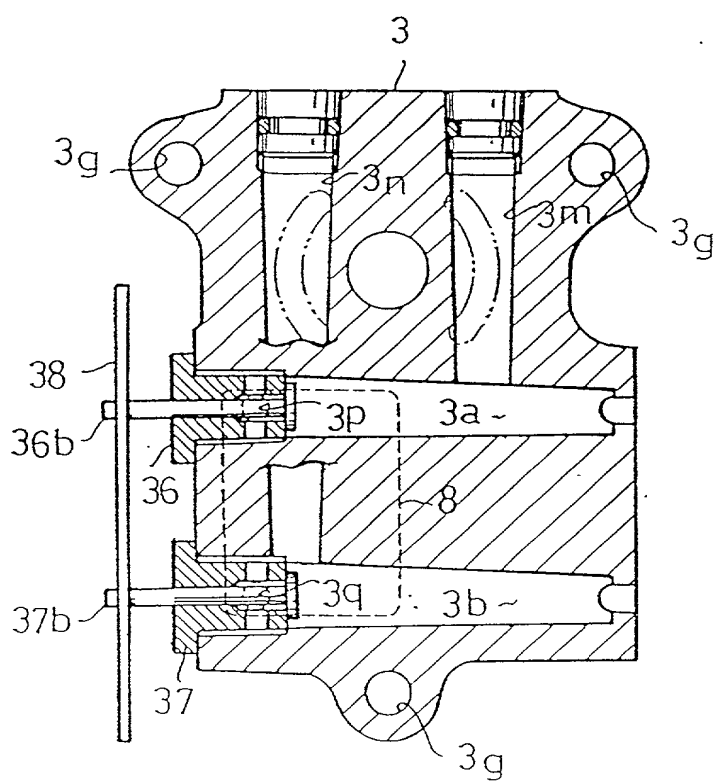


FIG.16





# Declaration and Power of Attorney For Patent Application

## 特許出願宣言書

### Japanese Language Declaration

私は、下欄に氏名を記載した発明者として、以下のとおり宣言する：

私の住所、郵便の宛先および国籍は、下欄に氏名に続いて記載したとおりであり、

名称の発明に関し、請求の範囲に記載した特許を求める主題の本来の、最初にして唯一の発明者である（一人の氏名のみが下欄に記載されている場合）か、もしくは本来の、最初にして共同の発明者である（複数の氏名が下欄に記載されている場合）と信じ、

Axle Driving Apparatus

その明細書を  
(該当する方に印を付す)

☐ ここに添付する。

☐ \_\_\_\_\_ 日に出席番号

第 \_\_\_\_\_ 号として提出し、

\_\_\_\_\_ 日に補正した。

(該当する場合)

私は、前記のとおり補正した請求の範囲を含む前記明細書の内容を検討し、理解したことを陳述する。

私は、連邦規則法典第37部第1章第56条(a)項に従い、本願の審査に所要の情報を開示すべき義務を有することを認める。

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

the specification of which

(check one)

☐ is attached hereto.

☐ was filed on \_\_\_\_\_ as

Application Serial No. \_\_\_\_\_

and was amended on \_\_\_\_\_  
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

私は、合衆国法典第35部第119条にもとづく下記の外国特許出願または発明者証出願の外国優先権利益を主張し、さらに優先権の主張に係わる基礎出願の出願日前の出願日を有する外国特許出願または発明者証出願を以下に明記する：

Prior foreign applications  
先の外国出願

P.63-55828	Japan	March 9, 1988
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願の年月日)
P.63-24193	Japan	February 3, 1988
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願の年月日)
U.63-79665	Japan	June 16, 1988
(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願の年月日)
P.63-67005	Japan	March 18, 1988

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Priority claimed  
優先権の主張

<input checked="" type="checkbox"/> Yes あり	<input type="checkbox"/> No なし
<input checked="" type="checkbox"/> Yes あり	<input type="checkbox"/> No なし
<input checked="" type="checkbox"/> Yes あり	<input type="checkbox"/> No なし
<input checked="" type="checkbox"/>	<input type="checkbox"/>

私は、合衆国法典第35部第120条にもとづく下記の合衆国特許出願の利益を主張し、本願の請求の範囲各項に記載の主題が合衆国法典第35部第112条第1項に規定の態様で先の合衆国出願に開示されていない限度において、先の出願の出願日と本願の国内出願日またはPCT国際出願日の間に公表された連邦規則法典第37部第1章第56条(a)項に記載の所要の情報を開示すべき義務を有することを認める：

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)  
(出願番号)

(Filing Date)  
(出願日)

(現況)  
(特許済み、係属中、放棄済み)

(Status)  
(patented, pending, abandoned)

(Application Serial No.)  
(出願番号)

(Filing Date)  
(出願日)

(現況)  
(特許済み、係属中、放棄済み)

(Status)  
(patented, pending, abandoned)

私は、ここに自己の知識にもとづいて行った陳述がすべて真実であり、自己の有する情報および信ずるところに従って行った陳述が真実であると信じ、さらに故意に虚偽の陳述等を行った場合、合衆国法典第18部第1001条により、罰金もしくは禁錮に処せられるか、またはこれらの刑が併科され、またかかる故意による虚偽の陳述が本願ないし本願に対して付与される特許の有効性を損うことがあることを認識して、以上の陳述を行ったことを宣言する。

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

委任状：私は、下記発明者として、以下の代理人をここに選任し、本願の手続を遂行すること並びにこれに関する一切の行為を特許商標庁に対して行うことを委任する。  
(代理人氏名および登録番号を明記のこと)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

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同第2発明者の署名 Shusuke Nemoto 日付 JAN 10, 1989	Second Inventor's signature Date
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郵便の宛先 Same as the above residence	Post Office Address

第3の共同発明者の氏名 (該当する場合)		Full name of third Inventor, if any	
同第3発明者の署名	日付	Third Inventor's signature	Date
住所		Residence	
国籍		Citizenship	
郵便の宛先		Post Office Address	
第4の共同発明者の氏名 (該当する場合)		Full name of fourth Inventor, if any	
同第4発明者の署名	日付	Fourth Inventor's signature	Date
住所		Residence	
国籍		Citizenship	
郵便の宛先		Post Office Address	

(Supply similar information and signature for subsequent joint inventors, if any.)